Sub new Spec paper SL#8

Information carrier

The invention concerns an information carrier with at least one external surface for the readout of optically readable information.

Such information carriers are, for example, printed pages, bank notes, packagings, glued-on labels, wrappers, pictures, etc. Information is printed or otherwise introduced onto these materials, and this information is visible for the most part (i.e. can be read or shown by light in the optically visible range). However, it can also contain information in the optically invisible range (e.g. information that can be read with UV or IR light).

Thus, as a rule, these information carriers possess at least one external surface, on which the information contained is visible from the outside. In the case of printed papers, this is the printed side of the page. In relief holograms, whose holographically contained information is introduced in a relief structure onto an outer surface, the holographically contained information is also visible upon observation of this outer surface or upon illumination of this outer surface with specific light sources. In the case of transparent information carriers, the information may lie in blackened or light-diffracting or light-refracting regions within the transparent material, so that the information is visible from more than one outer surface. In the case of cuboid-form information carriers, this can be the six outer surfaces, whereas in sheet-type information carriers, only the two opposite sides of the sheet are used.

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These materials are frequently protected against subsequent manipulation or copying. Also, such information carriers serve as safety seals, for example, for characterizing trademark products (electronic components, computer components, pharmaceutical products, image, sound and data media, clothing articles, etc.). There is also a need in the case of bank notes for safety against counterfeiting. For this purpose, information is introduced onto the information carrier by means of a correspondingly expensive process, which cannot be copied simply by means of a conventional copier for copying printed paper onto another information carrier. Thus, for example, reinforced safety seals with holographically stored information are utilized, which can be copied in principle only with expensive laser built-in apparatus for producing coherent light. Also, metal foils with impressed diffraction grids are used, which reflect light of different colors according to angle of observation.

In the case of these safety seals as well as basically for printed paper, there is frequently a need for an increased protection against copying or at least for a feature by means of which a copy can be distinguished from the original.

The object of the invention is to create an information carrier with increased protection against copying and/or with a feature for distinguishing the original from the copy.

The invention solves this object with the subject of claim 1.

Preferred examples of embodiment of the invention are described in the subclaims.

A transparent copy-protection film with a property of rotating the polarization of the readout light and/or a filtering property is introduced accordingly onto the at-least one external surface of the information carrier. The advantage of this copy-protection film lies in the fact that it cannot be recognized, for example, with the naked eye. If the information carrier is now copied with natural light, the copy no longer contains this copy-protection film. A polarizing foil (or an appropriate polarizer) placed over the copy and the original can distinguish the two from one another with appropriate alignment, since the original darkens at a specific alignment of the polarizing foil. In general, if copied with polarized light, the information of the original, for example, cannot be read out due to this specific alignment.

The information carrier can be, among others, any of the above-named materials, for example, a foil (e.g., in the form of a safety seal) or a more solid material, which is partially transparent throughout or keeps information stored in at least one intermediate layer lying inside the material (surface hologram, volume hologram, etc.). The information can be stored in the form of a property of the material of the information carrier that reflects, absorbs, refracts and/or diffracts the readout light.

Thus the information can be stored in an optically visible manner (i.e., recognizable in visible light) or in an invisible manner, e.g., visible only with UV light or IR light). The information itself can be contained as a three-dimensional hologram (spatial rendition of an object in full three-dimensional reproduction), two/three-dimensional hologram (flat motif against a three-dimensional

background), two-dimensional hologram (flat graphics) or as a diffraction pattern (e. g,, diffracting structures in diffraction foils). In addition, depending on the angle of observation (movement sequence when the information carrier is inclined relative to the source of illumination) or the illumination color, different motifs or different pieces of information can be stored.

The optically readable information may include any type of information, even purely geometric or irregular, (apparently) random patterns. On metal foils with diffraction patterns, frequently completely irregular patterns or also only purely regular surfaces are contained, which are depicted, for example, only in the colors of the rainbow. This “play on colors” also represents information in the sense of the invention.

Preferably, the optically readable information of the information carrier includes holographically recorded information. The phrase holographically stored information is to be understood in the sense that the information is contained as a whole also only in surface segments of the information carrier. Frequently, information is stored on foils in the form of holograms, and these foils are in turn glued onto products for purposes of protection against copying. These so-called safety seals serve for authenticating the product that is sold. Safety seals in the form of holograms are based on optical diffracting structures which are embedded in the foil layer. Depending on the angle of illumination and the viewing angle each time, the observer perceives different colors, patterns and motifs. The structure of these foil layers and the technical expenditure for their

production offer an effective protection against simple copying and thus against the marketing of counterfeit products with the copied safety seal.

The holographically stored information is protected particularly effectively against copying, since basically coherent light sources must be used for copying a hologram. These light sources also have the property that they emit polarized light (circularly or linearly polarized light).

In addition, for copying, a reconstruction beam of the hologram, which must pass through the copy-protection film at least once, must interfere with a reference light beam that does not pass through the information carrier (and thus the copy-protection film). Interference occurs, however, only if the light beams are not polarized perpendicularly to one another. By suitable selection of the copy-protection film, the latter can polarize the reconstruction light beam or the subsequent object beam directly perpendicular to the reference beam. If the copying film has an essentially pure polarization-filtering property, then the linearly polarized reconstruction beam is filtered, for example, so intensely that it can no longer interfere with the reference beam.

In order to increase safety against copying, the copy-protection film preferably has surface segments of different polarization-rotating or filtering properties. If a polarization-rotating foil is inserted between such a safety seal that is produced as the information carrier and the recording medium used for copying in order to eliminate the polarization effect of the copy-protection film, it can only have limited success in a few segments. If these surface segments are distributed purely randomly, then copying will once more be made difficult. Even

if the hologram could be read out in raster form with a laser beam, each read-out raster point of the object beam must again be compensated for individually relative to its polarization. This is not possible, however, without the associated technical expenditure.

Preferably, the surface segments of the copy-protection film, viewed together, represent an information pattern. This information pattern, on the one hand, in the case of holograms, can indicate directly on a copy, by the polarizing surface segments (or their negative) that the copy is [a falsification] by imprinting, for example, the word "counterfeit", etc. On the other hand, in the case of "normal" information carriers (such as printed paper), additional information (a pattern, an illustration or written information, etc.) can be contained as the copy protection, which can be recognized only with illumination of the copy-protection film by polarized light (for the case when surface segments or their complementary surfaces have polarization-filtering properties) or upon observation through a polarization filter (for the case when the surface segments or their complementary surfaces have polarization-rotating properties).

The information pattern of the copy-protection film preferably contains coded information, at least partially. In addition to the information that can be recognized, for example, directly by means of a polarization foil, there is still other contained information, which can be recognized only with a specific master key which is contained, for example, on the polarization foil. The same is preferably true also for the information on the information carrier.

It is particularly preferred that the coded information of the copy-protection film is the decoding key for the coded information of the information carrier, or vice versa. Therefore, the coded information is only visible if the copy-protection film is also copied exactly, which can hardly be done technically as a rule. For example, a master key can be coded in the information carrier relative to the recognizable motif itself, and this key only applies a uniform "gray haze" or the like over the motif so that it is not recognizable as such. The copy-protection film also contains coded information, which occurs only as a "gray haze" without the master key. If information carrier and copy-protection film are observed by means of a polarization foil or the like, then the keyed information of the copy-protection film is decoded by the information coded as the master key and can be recognized as decoded.

Preferably, if the information carrier is used as a safety seal, the information of the copy-protection film and/or of the information carrier contains at least partially individualized information. Thus, in particular, the coded information can be individualized for any product that needs to be secured (e.g., by a consecutive serial number, etc.). The individualized code can be introduced in a technically simple manner in the production of the information carrier serving as the safety seal, for example, by means of a transparent liquid crystal display (for the case when the code is introduced into the information carrier). During the copying, each safety seal must then be copied individually; one "impression" of a safety seal as a master copy no longer supplies the consecutive serial number.

In order to avoid the removal of the copy-protection layer from the information carrier without damaging it, the copy-protection film is introduced onto the information carrier with predetermined breaking places (e. g., perforations) or by means of an insoluble adhesive process (glues diffusing into the layers, bonding, etc.).

Preferably, a portion of the surface segments of the copy-protection film is formed as transparent holes that do not influence the polarization. In this way, the different surface segments can be produced in a very simple technical manner.

In order to further increase the copy protection, the perforations are preferably filled with materials which have a fluorescing, phototropic, light-storing and/or a photothermal property. These perforations are thus visible by means of appropriate heating, irradiating with suitable electromagnetic radiation, but they are not illuminated by these measures in the case of a simple copy of the copy-protection film without introducing these materials.

For a better readout of the hologram or to increase the copy protection, the information carrier containing holographic information is introduced onto a luminous surface over another external surface. It is most preferred if the luminous surface is comprised of an electrofluorescing material or a material emitting light under microwave irradiation. Thus the hologram is also visible in the dark, if the information carrier or the luminous layer is irradiated with appropriate electromagnetic waves or a voltage is applied to it.

In order to produce a "flat" light source, a point-light mask is arranged preferably between the additional external surface of the information carrier and the luminous surface.

In order to further increase the copy protection, one or more of the materials used is/are doped with specific substances in specific quantity ratios. These substances and their quantity ratios can be detected subsequently by means of mass spectroscopy, but as a rule only with the knowledge of the substances introduced and their quantity ratio. If this information is maintained confidential as much as possible, a copy is therefore practically impossible, or a copy can be distinguished from the original with high reliability.

Preferably, the information carrier is the external surface of an injection molded part, which has a surface structure with optically diffracting properties, at least in segments, as the information carrier. Thus a product can be particularly simply protected in that a surface structure has already been molded in the injection-molded housing part, and this structure serves as the information carrier (e.g., represents a hologram, etc.). The mold for producing this injection-molded part preferably has a recess for the uptake of an appropriate imprinting stamp with this surface structure as the negative. For further details, refer to the parallel application with the title "Injection-molded part, injection mold and injection molding method" of the same Applicant, which has the same application date, the disclosure of which is fully included in the present application.

The invention as well as additional advantages of the invention will now be explained on the basis of a preferred example of embodiment with reference to the attached figure.

A schematic representation of an information carrier 2 with holographically stored information, for example, is shown in the figure. This information carrier 2 can serve as a data medium for a large quantity of data or as a safety seal.

Basically, there are two types of holographs, surface and volume holographs. In the case of surface holography, the interference pattern is stored only in one plane – e.g., on a surface of information carrier 2, whereas in volume holography, the information is also contained in the volume depth.

The production of an information carrier 2 with a surface hologram is produced in a manner similar to producing phonograph records. As an original, an imprinting matrix is thus used, which has a surface relief containing the hologram as the interference pattern, and this relief is subsequently silver-plated chemically with a silver solution or is vacuu-deposited in high vacuum with a metal film. The metal film is reinforced by electroplating and stripped from the original, so that a matrix arises, by means of which, for example, thermoplastic plastics can be formed into phase holograms or imprinting matrices can be produced.

Now a copy-protection film 4 is glued onto an external surface 3 of this information carrier 2. The hologram is read out above this external surface 3: for example, a reconstruction beam strikes this external surface 3 from the outside, interferes with the diffraction pattern of information carrier 2 and a resulting object

beam leaves information carrier 2 again above external surface 3 (reflection hologram). A reconstruction beam can also fall onto the other external surface 5 of information carrier 2 and an object beam can leave external surface 3 (transmission hologram).

The copy-protection film 4 can be glued onto information carrier 2 such that a stripping of copy-protection film 4 disrupts this film 4 and/or information carrier 2, at least partially. A perforation can be introduced for this purpose in copy-protection film 4, which breaks the film up into small segments if it is stripped off. A diffusion adhesive may also be applied. This adhesive can diffuse into information carrier 2 and/or copy-protection film 4 such that its optical properties are purposely modified. Thus information can be incorporated with the targeted application of the adhesive.

The copy-protection layer 4 is, for example, a simple transparent plastic foil of cellophane, polyurethane, polypropylene or the like. Such plastic foils usually rotate the direction of polarization of the light depending on their thickness.

For a better understanding of the invention, a familiar copying process for copying holograms will be explained below, the so-called contact copy. As in conventional photography, information carrier 2 containing the hologram is placed on the copier medium (recording material), onto which the hologram is to be copied. If both carrier 2 and the copier medium are now irradiated with non-coherent light (or light of too-short coherent length), for copying the hologram, then the copy that is obtained would be extremely unsatisfactory. Scattering and

the finite distance between the two layers in the case of a contact copy cause high losses of information in the copying of hologram structures (interference patterns) present in the micrometer range.

Copying is thus conducted with coherent light, which originates, for example, from a laser source. Such light is basically polarized (linearly or circularly). In addition, the laser light of a laser source, which is used for copying, for reasons of coherency, is divided into two beams, the reconstruction beam for reconstructing the holographically stored image and the reference beam for recording a copy of the hologram in the recording material.

In the case of the contact copy, a distinction is made between a transmission copy and a reflection copy. In the case of the transmission copy, laser and recording material are found on opposite sides of the hologram layer, whereas they are found on the same side in the case of the reflection copy. The exclusively applicable copying method in the case of copying, for example, safety seals as information carrier 2, is the reflection copy, since the safety seal cannot be stripped without damage from its usually non-transparent carrier. A damaging of the safety seal in fact does not lead unavoidably to the loss of an information segment, since each region of the safety seal in principle bears the complete information, but, leads to a strong loss of contrast of the read-out object beam.

In the case of the reflection copy, the object beam read out from the reconstruction beam is reflected by information carrier 2 and reaches the recording material, where it interferes with another part of the light beam of the same laser source also acting as the reference beam and is recorded.

The glued-on copy-protection film 4 now prevents a contact copying of the hologram of information carrier 2 in the following way:

In the case of the contact copy, the reconstruction beam first passes through the copy-protection film 4, is rotated there relative to its polarization or filtered therein and reconstructs the hologram of information carrier 2 in an object beam. The object beam again passes through copy-protection film 4 and is again rotated in its polarization or filtered.

The object light rotated twice in its polarization now interferes with the reference beam of the laser which is still unmodified in its polarization, in the recording medium. It is true that light polarized perpendicularly to one another does not interfere with one another. If copy-protection layer 4 in the most favorable case effects a polarization of 45°, then the object light is thus polarized perpendicularly to the reference beam after the 2X polarization and consequently can no longer interfere with this beam. As a result, a contact copy is not produced. For other polarization rotations conducted by copy-protection film 4, the interference pattern is correspondingly weaker and thus leads to a copy with very poor contrast.

This is true also for all other types of copying, in which the light bundle used for copying is divided into a reconstruction beam and a reference beam, and the reconstruction beam passes through copy-protection film 4, but the reference beam does not.

Perforations 6 are made in copy-protection film 4 before and/or after film 4 is glued onto information carrier 4* (e.g., with a needle device, etc.). These perforations 6 thus divide copy-protection film 4 into surface segments 7, which again rotate the light relative to its polarization or filter it, and surface segments 6 (perforations 6), which do not change the polarization of the light that passes through. Holes 6 can thus be arranged in a pattern, so that coded and/or uncoded information is carried. Uncoded information can be recognized, if, for example, a polarization foil is applied to copy-protection film 4, which [foil] polarizes the light exactly perpendicularly to copy-protection film 4. Thus all surface segments 7 of copy-protection film 4, which are not perforations 6, appear as dark segments, whereas perforations 6 are brightly illuminated and expose their information.

The information represented by perforations 6 can also serve at least partially as a decoding key for coded information within information carrier 2. The coded information in information carrier 2 can thus also be present relative to a visible hologram but cannot be recognized as such. Thus, the person who makes the copy in general knows nothing of the presence of coded information.

Coding may consist of representing either a dark or light pixel of the information to be coded by means of four subpixels arranged in a square, of information carrier 2 and copy-protection film 4. A dark pixel, for example, corresponds to four dark subpixels, whereas a bright pixel corresponds to any two bright and any two dark subpixels. Overall, the subpixels of individual layers 2 and 4 are stochastically distributed, however, so that only a uniform gray haze

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* sic; 2—Trans. note.

can be recognized in information carrier 2 as well as also in copy-protection film 4 (in the case of observation with polarization foil or glasses). The only condition is that the two dark subpixels of each layer 2 and 4 coincide for a bright pixel of the information to be coded, whereas they do not directly coincide for a corresponding dark pixel.

This coding can also be applied only between copy-protection film 4 and a polarization foil that can be applied. Thus, perforations 6 that do not rotate the polarization can be seen only through the applied polarization foil, whose contained "gray" pixel pattern together with the "gray" pixel pattern of the perforation arrangement makes the information recognizable. Thus, for example, a running serial number can be perforated in the coded information of copy-protection film 4, which can be read out as the master decoding key with a uniform polarization foil. The running serial number, however, can also be introduced into information carrier 2 in coded or uncoded manner.

Perforations 6 can be filled with a material that has special optical properties. For example, this material can have a fluorescing, phototropic, photothermic property or in the case of electromagnetic radiation (e.g. high-frequency or infrared irradiation), it can emit visible light. In addition, it can also have light-storing properties (bacteriorhodopsin, etc.).

Also, chemical elements, compounds or substances selected for the material can be mixed in a specific quantity ratio. These materials can be further specified individually according to type and quantity ratio subsequently by means of mass spectroscopy. This targeted chemical "doping" thus serves as a

fingerprint of the foil. Alternatively or in addition, the remaining materials of the individual layers can also be doped with trace elements (for example, without essential change in their optical properties). In the case of possible combinations of "doping substances" and their quantity ratios that are infinite in principle, it is usually impossible to determine the latter and their quantity ratios without knowledge of the type of "doping substance" that is present. A corresponding evaluation of the mass spectrogram usually presumes knowledge of the substance to be detected. The Applicant intends to separately pursue this special doping of information carriers to be copy-protected (without copy-protection film 4).

This material, for example, is applied as a liquid onto the perforated copy-protection film 4 and is subsequently scraped off again, so that the material only remains behind in perforations 6.

A transparent sealing layer 8 is introduced onto copy-protection film 4, in order to protect copy-protection film 4 and information carrier 2.

The information carrier with hologram is itself optionally introduced by its external surface 5 onto a luminous layer 10 over a point-light mask 9.

Luminous layer 10 can be comprised of an electrofluorescing material and can illuminate the hologram in information carrier 2 from below after application of a voltage at luminous layer 10 (electroluminescence effect). It may also be comprised of a material that illuminates in the visible range, for example, when stimulated by microwave irradiation.

Point-light mask 9 serves for flat illumination of information carrier 2. The prerequisite for the reconstruction of the hologram contained therein is namely that light comes from a targeted direction. If the hologram is comprised of several elements, each of these lies opposite a transparent point of the point-light mask, so that each element is illuminated practically by its own reference light source as the reconstruction light source.